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ATMOSPHERIC PLANETARY BOUNDARY  
LAYER STABILITY, FLUXES, SPECTRA,  
AND SIMILARITY Final Report  
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The Martian Atmospheric Planetary Boundary Layer  
Stability, Fluxes, Spectra and Similarity  
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Final Report

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The major task of this grant culminated with the attached paper to be published in the Journal of Atmospheric Sciences, May 1994: this has been a collaborative effort with co-authors Landberg and Larsen, of Risø, Danish National Laboratory, over the past few years.

This is the first analysis of the of the high frequency data from the Viking lander and spectra of wind, in the Martian atmospheric surface layer, along with the diurnal variation of the height of the mixed surface layer, are calculated for the first time for Mars. Heat and momentum fluxes, stability, and  $z_0$  are estimated for early spring, from a surface temperature model and from Viking Lander 2 temperatures and winds at 44° N, using Monin-Obukhov similarity theory. The afternoon maximum height of the mixed layer for these seasons and conditions is estimated to lie between 3.6 and 9.2 km. Estimations of this height is of primary importance to all models of the boundary layer and Martian GCM's.

Model spectra for two measuring heights and three surface roughnesses are calculated using the depth of the mixed layer, and the surface layer parameters and flow distortion by the lander is also taken into account. These experiments indicate that  $z_0$ , probably lies between 1.0 and 3.0 cm, and most likely is closer to 1.0 cm. The spectra are adjusted to simulate aliasing and high frequency rolloff, the latter caused both by the sensor response and the large Kolmogorov length on Mars. Since the spectral models depend on the surface parameters, including the estimated surface temperature, their agreement with the calculated spectra indicates that the surface layer estimates are self consistent. This agreement is especially noteworthy in that the inertial subrange is virtually absent in the Martian atmosphere at this height, due to the large Kolmogorov length scale. These analyses extend the range of applicability of terrestrial results and demonstrate that it is possible to estimate the effects of severe aliasing of wind measurements, to produce a models which agree well with the measured spectra. The results show that similarity theory developed for Earth applies to Mars, and that the spectral models are universal.

Comparisons have been made during these analyses with the work of Sutton, Leovy and Tillman, the only other boundary layer analysis, and with the models of Haberle. Also, extensive comparisons between two methods of estimating surface temperatures have been made, one developed by Ronnholm and Leovy, and others by Haberle and collaborators at NASA Ames. These comaprison, and other analyses, were provided to Haberle as part of a collaboration several years ago. These results are of primary importance to all Martian meteorological investigations in the lower 30 km or so and it is imperative to extend them to other seasons. Without these results, turbulent and mesoscale models will continue to be speculative efforts and the GCM's will have no lower boundary conditions or "ground truth".